A NOTE ON THE THEORY OF THERMOELASTIC DISSIPATION

by

P. H. Fang and A. V. M. Ferris-Prabhu
National Aeronautics and Space Administration

In an attempt to explain the relaxation phenomena associated with thermoelastic dissipation in solids, Forte[1] introduced an interesting physical model of the dissipation of elastic waves. The result is used to analyze the experimental data of Randall et al.[2] We reproduce as a part of Figure 1, the results of Forte.

Forte concludes that the agreement in the low frequency region is satisfactory. and the deviation at high frequency is due to the mathematical approximation in the numerical evaluation of his theoretical equations. In an attempt to verify this contention, we have carried out the numerical computation directly. We will not reproduce Forte's function in this brief note. Suffice it to say that our summations over the indexes are carried out from 0 to 16 on IBM 709. and the resulting numerical values are correct to at least 4 significant figures over that whole frequency range. The result is shown in Figure 1. The improvement expected by Forte is not realized.

The problem of the broadening of the relaxation peak has general interest in many branches of physics, and a successful physical model is therefore, of a great importance. When a model is not available, a numerical analysis based on the fundamental mathematical formulation of dispersion theory will, at least, provide consistent numerical values of the relaxation time, the activation energy, etc. This approach has been used in the analysis of some experimental data of the Bordoni peak.[3] By employing the same procedure and an associated empirical relaxation function, the so-called Davidson-Cole function,[4] with $\beta = 0.2$, we obtained a curve inserted in Figure 1. A comparison shows that the empirical curve describes the experimental data best. Since the analytic properties and the numerical tabulations of this empirical formula are quite well-known,[3] we suggest this empirical formula can be used to test physical models.

REFERENCES

1. B. Forte, Proc. Third Intern. Congr. Acoustics, (Stuttgart, 1959) p. 597.

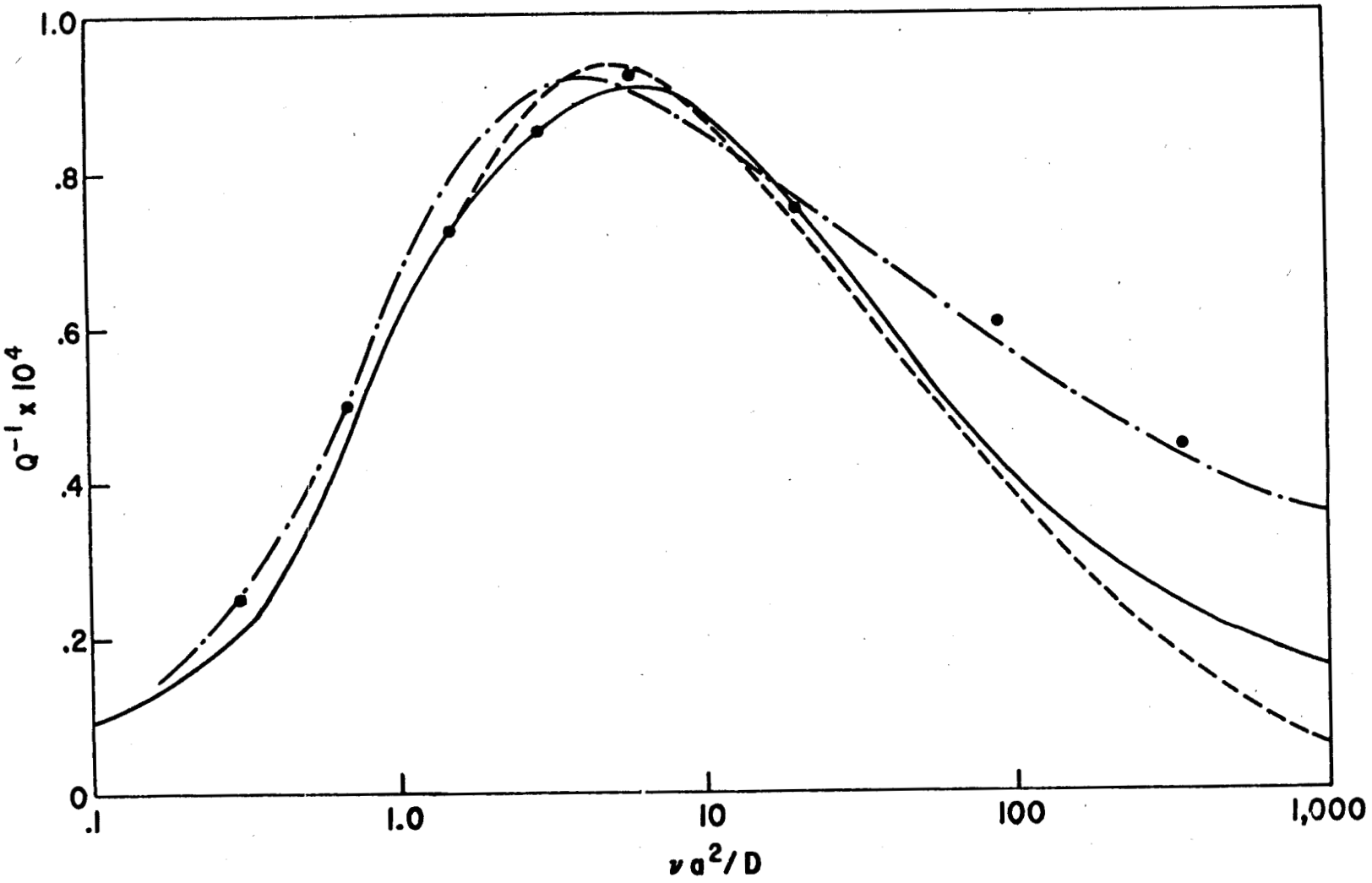
2. R. H. Randall, F. C. Rose and C. Zerner, Proc. Phys. Soc. 52, 152 (1940)

3. P. H. Fang, Nuovo Cimento 36, 1173 (1965)

4. D. W. Davidson and R. H. Cole, J. Chem. Phys. 19, 1484 (1951)

FIGURE

Figure 1. •, data of Randall et al., (——) Forte's approximated curve; (— —) exact curve based on Forte's equation; (—•—) curve based on Davidson-Cole Function.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